Light Microscopy of Carbon Steels

Leonard E. Samuels

A revised and expanded edition of Optical Microscopy of Carbon Steels

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Preface

This book is a revised and expanded edition of *Optical Microscopy of Carbon Steels,* "optical" in the title having been changed to "light" to adopt the now-preferred term for a microscopical technique in which light is used as the investigative radiation. Strictly, the technique used in metallography should be described as "reflected light microscopy," (but) "reflected" is usually omitted and taken for granted. However, the objective of the book remains unchanged, namely, to illustrate and develop an understanding of the range of microstructures that are formed in carbon steels by varying the carbon content and the thermal and mechanical treatments. The fact that a lengthy book is required to cover this range is an indication of the remarkable versatility of carbon steels. This is, in turn, an indication of why carbon steels have been the mainstay structural material of engineering practice for three millennia.

Light microscopy is, of course, not the only technique available for investigating the structure of metals. In fact, it only occupies the base level of an expanding pyramid of techniques of increasing power and complexity. Scanning and transmission electron microscopy are perhaps the most important of these more complex techniques. Light microscopy is, nevertheless, still the most widely used technique. In many smaller laboratories, it is the only technique available. In more advanced laboratories, it constitutes a necessary part of a wider armory of investigational techniques. This book is directed to establishing what can, and what cannot, be elucidated by light microscopy in all of these circumstances. While this book in no way purports to be a treatise on the physical metallurgy of steels, it does attempt to develop an understanding of the physical phenomena involved in the formation of the structures illustrated. This is because sound interpretation of the structures and their variations likely to be encountered in practice cannot be expected in the absence of a reasonably deep understanding of this nature. Considerable advances have been made in many of the topics of interest since the publication of the first edition. Revisions and additions have been made to the text to incorporate these advances. The references quoted have also now been selected principally as a guide to recommended sources of further information.

The subject matter has been expanded in a number of areas principally to incorporate the consequences of the remarkable developments in steelmaking technology that have been implemented since the first edition was published. The first of these is the widespread introduction of continuous casting practices. All of the illustrations of wrought materials in the first edition, most of which are also included in the present edition, are of materials that had been batch cast in large ingot. These ingots had then been reduced considerably by hot rolling, first by breaking down in a massive primary mill and then in a series of smaller secondary mills. However, much of the steel produced in recent decades has been cast continuously in comparatively thin sections, and this has obviated the need for large size reductions in hot rolling. The segregation patterns developed by the two casting procedures characteristically are different, and attention is drawn in appropriate sections to these differences. Otherwise, microstructures are not affected. Thus, the photomicrographs illustrating materials produced by the ingot route can be taken, with few exceptions, also to be representative of continuously cast material. The exceptions are noted.

Another series of developments in steelmaking practices has enabled the carbon content of the product to be reduced to a very low level—to a level, in fact, at which carbon plays little or no role in determining properties. Strengthening is then

obtained by other means that require the addition of small amounts of other types of alloying elements. This has enabled a whole new range of so-called "interstitial-free" or "high-strength low-alloy" steels to be developed that have markedly improved properties. These steels can scarcely be described as being carbon steels, but are so closely related to—and are substitutes for—true carbon steels that they need also to be considered. These considerations, however, necessarily have to be limited because only a limited amount of useful information can be obtained on these steels by light microscopy.

Leonard E. Samuels

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